Canada.
FISHERIES RESEARCH BOARD (OF CANADA)
Biological Station, St. Andrews, N.B.

General Series Circular (No. 38) April, 1963

PHOTO BY C. J. KERSWILL

Chemical Conditions in the Northwest Miramichi River from 1960 to 1962

by

John B. Sprague and W. Victor Carson

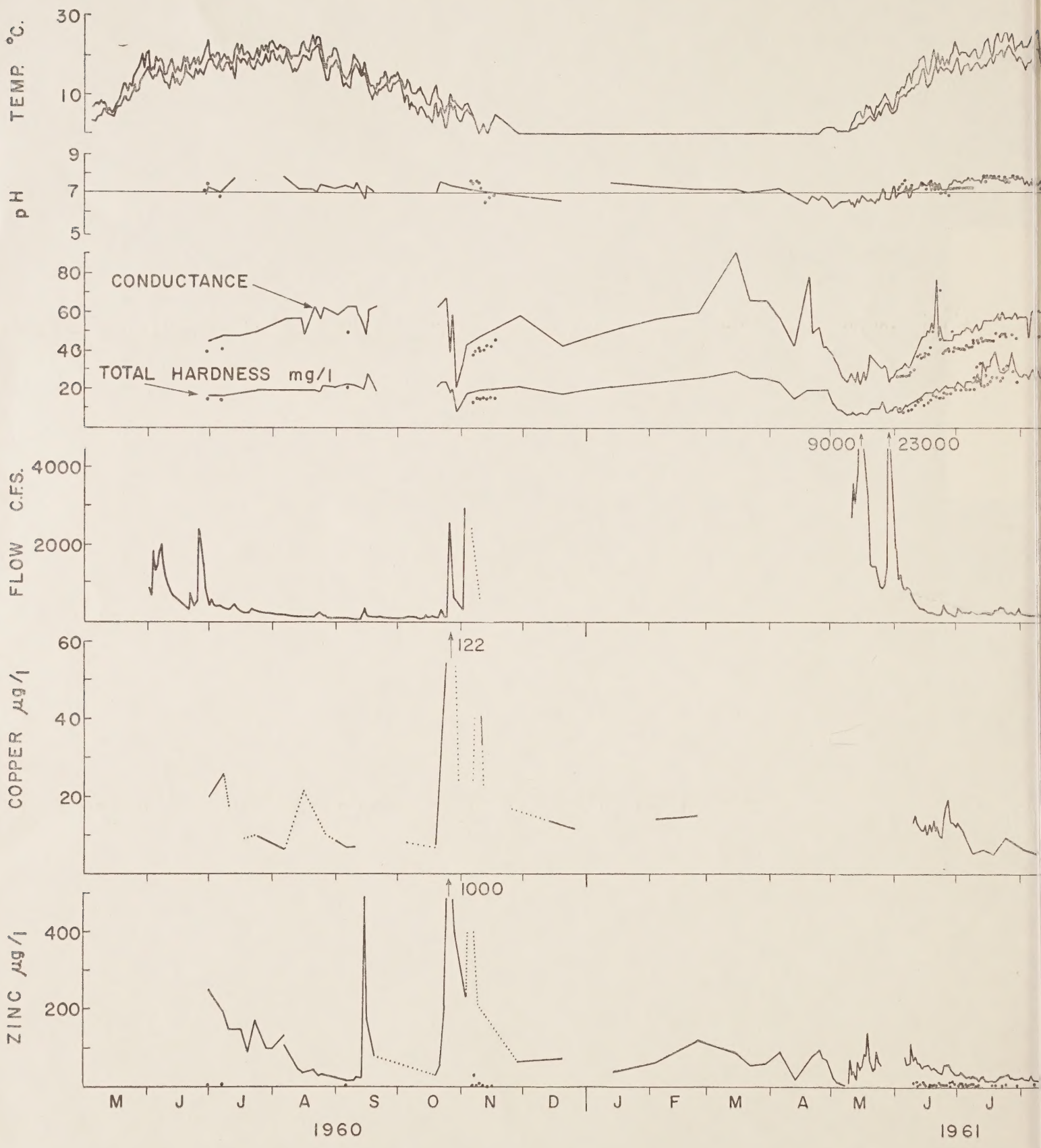
The N.W. Miramichi is one of the famous salmon rivers of the Maritime Provinces. It is here that the Fisheries Research Board has carried out studies of natural history of salmon in recent years. Since 1960, part of the research has dealt with effects of mining pollution on fish life. We have followed chemical conditions as background information for this research.

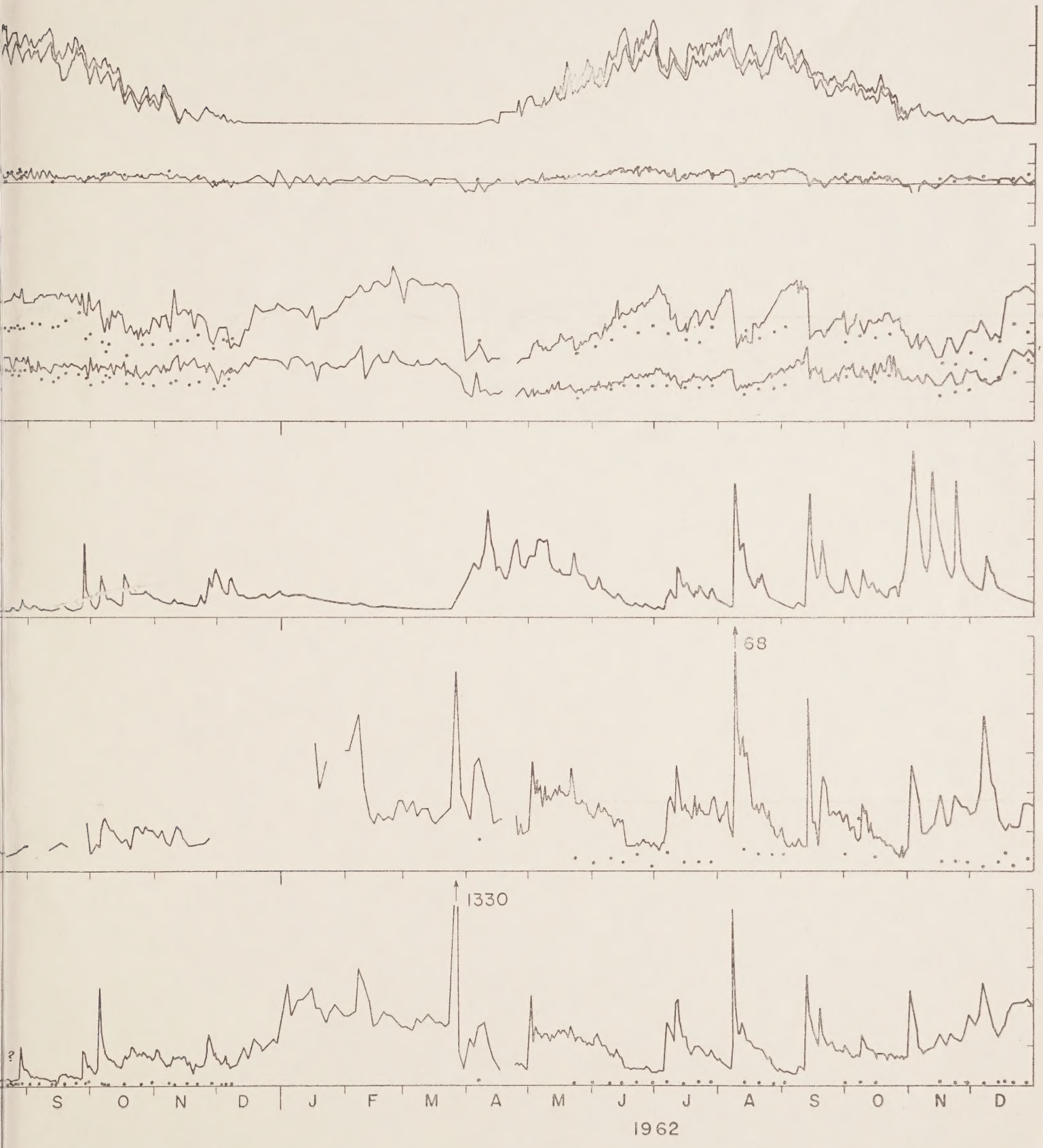
We have written this circular so that a general description of chemical results will be available to anyone interested. The concentrations of zinc and copper show the degree of mining pollution over the years. Probably of more lasting interest are the seasonal changes which we found in basic water chemistry. These are natural changes, and as far as we know, have not been shown before by such frequent sampling of a river in the Maritimes area.

The results are shown in the graph on the inside pages. The jagged lines in the graph represent conditions in the section of river near Curventon, N. B. This section of river is affected by mining pollution which enters via the Tomogonops R., 15 miles upstream from Curventon. There is a salmon counting fence at Curventon, which is seven miles above the head of tide. The small black circles clustered along the lines are results for the unpolluted section of Miramichi upstream from the mouth of the Tomogonops R.

Natural changes with the seasons.

The yearly cycle of water temperatures is in the uppermost strip of the graph. In the warm season, temperatures were taken twice a day at Curventon, usually at 8 a.m. and 5 p.m. During July and August of most summers, late afternoon temperatures rise to


TEMP. °C.
30
10
pH
9
7
5
CONDUCTANCE
TOTAL HARDNESS mg/l
80
60
40
20
FLOW C.F.S.
4000
2000
9000
23000
COPPER µg/l
60
40
20
122
ZINC µg/l
400
200
1000
M J J A S O N D J F M A M J J
1960
1961


68
1330
?
S O N D J F M A M J J A S O N D
1962

the vicinity of 68 to 76° Farenheit (20 to 25° Centigrade). However during the cold summer of 1962, afternoon water temperatures were often below 60° F. (about 15° C.) and morning temperatures sometimes approached 50° F. (10° C.). Freezing temperatures (0° C.) prevailed from late November to April or May.

The second strip down on the graph is for pH, a measure of the acid or alkaline reaction of the water. We found that this was never far from the neutral point of pH 7. The water naturally tends to be a little more alkaline during the summer months.

Electrical conductance and total hardness both measure the various salts which are dissolved in the water. These qualities fluctuate together and drop to low levels during floods and freshets. This is because rain or snow-melt contains very little dissolved material. The upstream portion of the Miramichi falls into the category of "very soft water" at all times of year. The downstream section of river sometimes rises into the "soft" category. This means that the river is on the whole rather poor in dissolved nutrients, compared for example to rivers flowing through areas of rich farmland.

The flow of the river is measured in cubic feet per second. The flood of about 23,000 c.f.s. in May 1961 was very severe. Among other damage it dislodged part of the bridge 6 miles upstream of Curventon. In 1962, the usual large spring freshet did not occur, but there was a series of freshets all summer and autumn.

Heavy-metal pollution.

The copper and zinc concentrations are measured in micrograms per litre which is about the same as parts per billion (p.p.b.). In order to put these results into perspective, it may be stated that experiments at St. Andrews show that young salmon are killed by about 600 p.p.b. of zinc alone or 40 p.p.b. of copper alone. Other laboratory experiments show sub-lethal effects (avoidance reactions by the fish) at about 10 or 20% of these concentrations. This is about 120 p.p.b. of zinc alone or 10 p.p.b. of copper. The two metals together cause similar effects at even lower concentrations. These results are for water of total hardness of 20, like the Miramichi in the spring-time.

In the unpolluted upstream section of the N.W. Miramichi, zinc and copper were generally in low concentrations. The 1962 results show that copper was usually 5 p.p.b. or less, and averaged 3 p.p.b. Zinc was generally less than 10 p.p.b., and also averaged 3 p.p.b. in 1962.

Metal concentrations at Curventon decreased during July and August 1960. Heavy pumping of mine water into the Tomogonops system had taken place from June 15 to July 7. In spite of clean-up efforts at the mine after this, there were extremely high concentrations of metal in the river during freshets in September, October, and November. Apparently rain and stronger streamflow flushed greater quantities of waste material from the mine property and down the Tomogonops system.

Throughout 1961, there were few high peaks of zinc concentration.

The first sample in 1962 showed a distinct rise in zinc. This may have been related to operations at the mine in preparation for reopening of the mill at about this time. On March 26, there were extremely high concentrations of zinc and copper. This happened during the first few days of increased run-off during the spring break-up. For the last half of 1962, fluctuations of zinc and copper are remarkably similar to those of river flow.

Additional copies of this circular may be obtained by writing to the Director of the Biological Station at St. Andrews. For those engaged in similar work, there are a few copies of a detailed manuscript report. Statements and conclusions in this circular are based on facts presented in the manuscript report.

We wish to thank Dr. R. W. Boyle and Mr. A. Y. Smith of the Geological Survey of Canada for advice and for carrying out the metal analyses up to early August 1960. Mr. J. E. Peters, of the Department of Northern Affairs and National Resources, kindly sent us the data for river flow, which is still provisional.